Various mechanical devices for effecting the explosion of torpedoes by their collision with a ship were employed by the Americans, a few of which proved very effective. But although in point of simplicity and cost, a system of defence by means of mechanical torpedoes possessed decided advantages over any extensive arrangements for exploding submarine mines by electric agency, their employment was attended by such considerable risk of accident to those at whose hands they received application that, under many circumstances which were likely to occur, they became almost as great a source of danger to friend as to foe.

The most important advantages secured by the application of electricity as an exploding-agent of submarine mines were as follows:—They might be placed in position with absolute safety to the operators, and rendered active or passive at any moment from the shore; the waters which they were employed to defend were therefore never closed to friendly vessels until immediately before the approach of an enemy; they could be fixed at any depth beneath the surface (while mechanical torpedoes must be situated directly or nearly in the path of a passing ship), and they might be removed with as much safety as attended their application.

There were two distinct systems of applying electricity to the explosion of submarine mines. The most simple was that in which the explosion was made dependent upon the completion of the electric circuit by operators stationed at one or more posts of observation on shore; such a system depended, however, for efficiency, on the experience, harmonious action, and constant vigilance of the operators at the exploding- and observing-stations, and was, moreover, entirely useless at night, and in any but clear weather.

The other, which might also be used in conjunction with the foregoing, was that of self-acting mines, exploded either by collision with the ship, whereby circuit was completed through the inclosed fuze, or by the vessel striking a circuit closer, whereupon either the mine, moored at some depth beneath, was at once fired, or the necessary signal was given to the operator on shore.

Continental nations had followed in our footsteps, in providing themselves with equipments for defensive purposes by submarine mines, and the Danes, Swedes, and Norwegians had pursued the subject of submarine mines with special activity and success.

In the United States the subject of the utilisation of electricity as an exploding-agent for war purposes was being actively pursued, and important improvements in exploding instruments, electric fuzes, and other appliances had been made by Smith, Farmer, Hill, Striedinger, and others already mentioned, while no individual had contributed more importantly to the development of the service of submarine explosions than General Abbot, of the United States Engineers.

Illustrations of actual results capable of being produced in warfare by submarine operations had hitherto been very few; but of the moral effects of submarine mines there had already been abundant illustrations. In the war carried on for six years by the Empire of Brazil and the Republic of Uruguay and the Argentine Republic of Paraguay, the latter managed, by means of submarine mines, to keep at bay, for the whole period, the Brazilian fleet of fifteen ironclads and sixty other men-of-war. In the Russo-Turkish war, submarine mines and torpedoes were a source of continued apprehension; and the French naval superiority was paralysed, during the Franco-German war, by the existence, or reputed existence, of mines in the Elbe.

The application of electricity to the explosion of military mines, and to the demolition of works and buildings, had been of great importance in recent wars in expediting and facilitating the work of the military engineer. The rapidity with which guns, carriages, &c., were disabled and destroyed by a small party of men who landed after the silencing of the forts at Alexandria, illustrated the advantages of electrical exploding arrangements, combined with the great facility afforded for rapid operations by the power possessed of developing the most violent action of gun-cotton, dynamite, &c., through the agency of a detonator.

The application of electricity to the explosion of mines for land-defences during active war was not an easy operation, inasmuch as not only the preparation of the mines but also the concealment of electric cables and all appliances from the enemy entailed great difficulties, unless the necessary arrangements could have been made in ample time to prevent a knowledge of them reaching the enemy.

But few words were needed to recall to the minds of civil engineers the facilities which the employment of electricity to explosive purposes afforded for expediting the carrying out of many kinds of works in which they were immediately interested. Electrical blasting, especially in combination with rock-boring machines, had revolutionised the operation of tunnelling and driving of galleries; and although in ordinary mining and quarrying operations the additional cost involved in the employment of fuzes, conductors, and the exploding-machine was not unfrequently a serious consideration, there were, even in those directions, many occasions when the power of firing a number of shots simultaneously was of great importance. There was little doubt, moreover, that accidents in mining and quarrying would be considerably reduced in number if electrical blasting were more frequently employed.

The conveniences presented by electric firing arrangements under special circumstances were interestingly illustrated by a novel proceeding at the launch of a large screw steamer at Kinghorn in Scotland, which was recently accomplished by placing small charges of dynamite in the wedge-blocks along the sides of the keel and exploding them in pairs, hydraulic power being applied at the moment that the last wedge was shot away.

In the deepening of harbours and rivers and in the removal of natural or artificial submerged obstructions, the advantages of electric firing were so obvious that extended reference to them was unnecessary.

A substitute for electrical firing which had been applied with success to the practically simultaneous firing of several charges consisted of a simple modification of the Bickford fuze, which, instead of burning slowly, flashed rapidly into flame throughout its length, and hence had received the name of instantaneous fuze or lightning fuze. The fuze burned at the rate of about 100 feet per second; it had the general appearance of the ordinary mining fuze, but was distinguished from the latter by a coloured external coating. Numerous lengths of this fuze were readily coupled up together so as to form branches leading to different shot-holes, which might be ignited together so as to fire the holes almost simultaneously. In the navy this fuze was used as a means of firing small gun-cotton charges to be thrown by hand into boats when these engaged each other, the fuze being fired from the attacking boat by means of a small pistol, into the barrel of which the extremity was inserted.

THE IRON AND STEEL INSTITUTE

THE annual meeting of this society took place at the Institution of Civil Engineers on May 9, 10, and 11 last. On the first day the chair was taken by the retiring president, Mr. Josiah T. Smith, but after some formal business had been gone through he vacated it in favour of the president elect, Mr. B. Samuelson, M.M., F.R.S. The latter proceeded to read an able address, dealing mainly with the great progress which had taken place in the iron and steel industries since the Institute was founded in 1869. He remarked on the very large makes of pig iron which were now going on in American blast furnaces, and stated that these were found to be economical even as regards fuel and wear and tear of the lining. He then dwelt at some length on improvements in the manufacture of coke, especially with a view to recovery of the waste products. The deterioration which was feared would result as regards the coke itself had not appeared in the case of the Simon-Carvés ovens, worked by Messrs. Pease and Co., who were recovering oil and tar to the value of 4*s*. 2*d*. per ton of coal. Against this was to be set increased expenses to the amount of 1*s*. 4*d*. per ton of coke, and also interest on first cost and maintenance. He further referred to the Jameson process lately described before the Institution of Mechanical Engineers, and observed that this principle was being applied to recover oil and ammonia from smouldering waste-heaps at the pit bank. Passing on to the manufacture of steel he spoke with much approval of the Bicheroux gas puddling furnaces at Ougrée in Belgium, where gas obtained from slack was used for puddling, and gave more heat for steam-raising purposes than the old system. Speaking of the future demand for iron and steel, he pointed out that the United States had fifty times and Russia five times as many miles of railway per million of people as had our Indian Empire; and strongly urged the further development of railways in the latter country. The address also touched upon many other points connected with iron and steel, such as the increased production of Bessemer and Siemens steel, the great diminution in their price, the immense increase in shipbuilding, the proposed improvements in the patent law, and the better relations now existing between masters and workmen. At the conclusion of his address the president presented the Bessemer medal to Mr. J. G. Snelus of Workington for his achievements in introducing the basic system for the making of steel. A similar medal, bestowed upon Mr. S. G. Thomas, was reserved until his return to England.

The meeting then took up the discussion on a paper by Mr. Snelus on the Chemical composition and testing of steel rails. This paper was read at the Vienna meeting of the Institute and its discussion postponed. Mr. Snelus now added particulars of a new test for the hardness of rails, which consisted in driving a uniform punch under uniform pressure into a piece of the rail, and measuring the depth of the hole produced. Various experiments had satisfied him that this depth would be inversely proportional to the hardness of the rail. M. Cazés, engineer to the Lyons Railway, read a very long note in French on the same subject, the point of which was that, as he maintained, the wearing power of the rail depends not only on its chemical composition but also on the temperature in rolling and the amount of compression which it has experienced while being rolled. He stated that a percentage of carbon varying from ½ to 1 per cent. was found in France to give the best result for rail heads.

Two papers were then taken together: the first of these was by Mr. Wm. Parker (Chief Engineer and Surveyor of Lloyd's), on the Use of steel castings in lieu of steel and iron forgings for ship and marine engine construction. This paper gave the results of an important investigation made by Lloyd's Registry into the applicability of steel castings to heavy articles such as crank shafts, sternposts, &c., which had hitherto been chiefly made in forged iron. The result was to convince the Committee that such constructions can be made of cast steel quite as good for the purposes intended as those of wrought iron, and without the uncertainty which always exists more or less in large iron forgings. The making of such castings is mainly in the hands of three firms, who, however, differed very materially in their views of the best mode of proceeding, especially as to whether the metal should be melted in crucibles or in the ordinary open hearth. At Terre Noire, where such castings are also made, great importance is attached not only to annealing but also to tempering them in oil; and the author gave particulars of experiments made on this subject, which showed that such treatment had a marked effect in increasing the strength of the specimens whilst slightly diminishing their ductility. Reference was made to the distinction between forged steel and cast steel, and a number of experiments were quoted on similar bars of both these materials and also of wrought iron. In these experiments the strength of the cast steel specimens was in every case greater than those of the wrought iron, whilst the ductility was about the same. With the forged steel the tensile strength was designedly made low, but the ductility was very high. Taking the product of the ultimate strength and ultimate elongation as representing roughly the quality of the material, it appears that the cast steel is one-third higher than wrought iron on an average, whilst the forged steel is three times as high. Transverse tests, both by steady pressure and by impact, and also torsion tests, gave results practically similar. Finally some experiments made by Mr. James Neilson on steel, partly as cut from the ingot and partly as hammered or rolled down to a comparatively small thickness, showed that the latter process produced a very decided increase both as to strength and ductility in some cases, although the results were not very uniform. For casting crank shafts and similar work Lloyd's Committee considered that the tensile strength of the steel should not exceed thirty tons per square inch, and that a piece 1¼ inch square should bend cold through an angle of 90 degrees.

The second paper was by Mr. Wm. D. Allen, of Henry Bessemer and Co., and was on Bessemer steel in its cast and unwrought state. The object of this paper was to dispel the idea that Bessemer steel is not a safe material for casting on account of the frequent presence of cavities or blowholes within it. From daily experience Mr. Allen affirms that perfectly sound castings can be made from Bessemer steel, provided that the ladleful is alloyed either with ferromanganese or with some iron ore rich in silicon. In order that this alloy may mingle perfectly with the steel, the ladle should be violently stirred by means of an agitator, already described to the Institute. Of such steel, the reader stated that nearly 500 hydraulic cylinders had been made, and tested up to two, three, or even four tons per square inch.

An interesting discussion followed these papers. Mr. James Riley doubted whether the crucible process produced a result more uniform than the open hearth, and spoke strongly in favour of annealing and tempering in oil. He also doubted whether the work put upon forged steel gives the advantage which was claimed for it. Mr. Hall (Messrs. Jessop and Sons, of Sheffield) defended the crucible process, but disparaged Bessemer castings. Sir Henry Bessemer, however, considered that the agitator had overcome the difficulty which previously existed in making sound castings in his steel, while Sir Wm. Siemens observed on the danger that castings may contract unequally in cooling, and on its complete cure by annealing. He suggested an explanation for the curious fact of the advantage due to oil-hardening, namely, that the oil produced a compression of the outer layers, which acted on the rest of the mass, and was of more effect than any mechanical pressure could be.

The second day's proceedings opened with the reading of two papers on the vexed question of hot blasts and high furnaces. The first was by Mr. Wm. Hawdon, who gave the particulars of comparative experiments made on one of Messrs. Samuelson's furnaces at Middlesborough, which had been supplied alternately with blast from pipe stoves at 990° F. and with blast from firebrick stoves at 1400° F. The final result was an increase in the make per week from 400 to 458 tons of pig, a diminution in the coke per ton from 23·8 to 22·3 cwt., and at the same time an improvement in the quality of experiments at the various temperatures of blast between these two limits showed a gradual rate of improvement. At the same time the temperature of the escaping gases was diminished from 468° to 448°, and the volume, of course, was diminished also. Comparing the two modes of heat, he showed that the area of heating surface in proportion to the cubic capacity of the stove was much greater in the firebrick than in the pipe stove, giving a corresponding improvement in effect, and that the gases escaping from the chimney, which in the pipe stoves had a temperature of 1240° F., in the brick stoves were as low as 250° F. The result was to effect a very considerable saving of gas used for heating the blast, which gas may, of course, be utilised for steam-raising or other purposes.

The second paper was by Mr. I. Lowthian Bell, F.R.S., and dealt with the Value of successive additions to the temperature of air used in smelting iron. This paper was to some extent a rejoinder to those of Mr. Charles Cochrane, recently read before the Institution of Mechanical Engineers. Mr. Bell first considered the proposed application of hydrogen, or what is called water gas, to the blast furnace, and showed that this could produce no advantage in saving of heat. He then dealt with the question of the possible economy of coke in an ordinary furnace, and reiterated that a limit was placed to such economy by the fact that when the escaping gas consists of carbonic oxide and carbonic acid in the proportion of 2 to 1, these combined gases can no longer produce any effect in reducing iron ore. Hence the very great saving of fuel which had at first been effected by enlarging the size of the furnaces and increasing the heat of the blast, had now nearly reached its limit; which Mr. Bell still held to be represented by a capacity of about 15,000 cubic feet, and a temperature of about 1000° F. He dealt with the suggestion that the heating of the blast could be advantageously used to replace the heat evolved in burning carbonic oxide and carbonic acid; and showed that to effect any great improvement in this particular would require blasts of too high temperature to be practically available. He commented upon the results with the furnace at Messrs. Samuelson's works, and considered that the increase in the make must be due to the increased quantity of blast rather than to its higher temperature. He admitted a saving in coke of about 1 cwt., but he observed that on the other hand the furnace was driven very slowly, only supplying about half the weight of pig iron per cubic foot of capacity which was usually supplied by the furnaces in the Cleveland district.

Mr. Bell's position was strongly assailed by Mr. Charles Cochrane; but although the questions between them were still further debated, it can hardly be said that they are completely settled. The problem is one which involves several independent factors, and a variation in any one of these might produce a large effect on the final result. It was so far fortunate that on this occasion the question of stoves and of blast furnaces was considered together, and not separately, as is often the case; but there are still other matters to be taken into consideration. One of these, for instance, is the distance between the tuyeres at the bottom of the furnace. Mr. Cochrane confidently predicted that an alteration in this particular would effect a very important saving in Messrs. Samuelson's furnaces. The large economy actually realised by the use of brick stoves was commented upon by several speakers; but the advantage of increasing the capacity of furnaces appeared to be doubted by two very high authorities upon the subject, Mr. Edward Williams and Mr. E. Windsor Richards.

On Thursday afternoon the paper read was on the Northampton iron ore district, by Mr. W. H. Butlin. It gave an interesting description of this district, well known to travellers on the main line of the Midland Railway, in which, however, the deposits of ore have only been developed within the last thirty years. The paper also contained analyses of the ore, which is of a very variable character, and also of the limestone, slags, &c.

On Friday morning the first paper read was by Mr. John Stead of Middlesborough, on a New method for the estimation of minute quantities of carbon. The author had found that the colouring matter, which is produced by the action of dilute nitric acid upon white iron and steel, has the property of being soluble in potash and soda solutions, and that the alkaline solution has about two and a half times the depth of colour produced by the ordinary acid solutions. Hence it occurred to him that the colour-matter might be separated from the iron, as an alkaline solution, by simply adding an excess of sodium hydrate to the nitric acid solution of iron, and that the colour solution thus obtained might be used as a means of determining the amount of carbon present. This method is found to succeed well, as small a quantity as 0·03 per cent. of carbon being readily detected. The method of using it was described, and also experiments made to determine (1) the influence of heating the nitric acid solution for a longer or shorter time; (2) the effect of using an excess of nitric acid to dissolve the steel; (3) the effect on the solvent power of using a greater or less quantity of soda solution; (4) the effect of the presence of small quantities of chlorine. All these experiments proved satisfactory as regards the new process. An improved form of chromometer was also described.

The next paper was on the Production and utilisation of gaseous fuel in the iron manufacture, by Mr. W. S. Sutherland of Birmingham. It was of a somewhat discursive character, containing various suggestions, especially as to a method of making wrought iron by the converter process; but its chief object was to describe the production of a cheap form of heating gas, which the author has used largely for the welding up of boiler-flues, tubes, &c. In this process part of the fuel is burnt, as completely as possible, to carbonic acid and water, but the resulting heat is stored up partly in the remainder of the fuel and partly in regenerators, that in the regenerators being made to heat up to a sufficiently high degree a quantity of steam. This superheated steam is passed through the hot fuel, and forms with it carbonic oxide and hydrogen, which go away to be stored up and used. With this process about 55,000 cubic feet of gas is made per ton of Staffordshire coal, and at a cost of about 3*d.* per 1000 cubic feet, its heating power being about one-half that of coal gas. The author pointed out that it was most important to prevent as far as possible the formation of carbonic acid, and that for this a high temperature (say 1200° C.) was required.

The following papers were taken as read:—On Coal-washing machinery, by Mr. Fritz Baare; on the Tin-plate manufacture, by Mr. E. Trubshaw; and on Improvements in railway and tramway plant, by Mr. Albert Riche.

SCIENTIFIC SERIALS

American Journal of Science, April.—Review of De Candolle's origin of cultivated plants, with annotations on certain American species, by A. Gray and J. H. Trumbull.—Remarks on Glyptocrinus and Reteocrinus, two genera of Silurian crinoids, by C. Wachsmuth and F. Springer.—Smee battery and galvanic polarisation, by H. Hallock.—The age of the Southern Appalachians, by O. B. Elliott.—Evolution of the American trotting-horse, by W. H. Brewer.

IN the *Annalen der Physik und Chemie* for 1883, part i., Ernst Pringsheim has an elaborate paper on the theoretical and practical aspects of Crooke's radiometer. This is followed by essays on Stokes's law of fluorescence, by Ed. Hagenbach; on special cases of crystallisation, by E. Lommel; on the heat-conducting power of fluids, by L. Graetz; on the relation of specific heat in gases and vapours, by P. A. Müller; on the constant result of internal friction and galvanic conduction in relation to temperature, by L. Grossmann; and on A. Guebhard's proposed method of determining equipotential lines, by Hugo Meyer. Part ii. contains papers by O. Grotian on the power of electric conduction of some cadmium and quicksilver salts in liquid solutions; by W. C. Röntgen, on the change produced by electric power in the double fracture of quartz (continued in part iv.); by A. Kundt, on the optical character of quartz in the electric field; by H. Meyer, on the magnetising function of steel and nickle; by A. von Waltenhofen, on the history of recent dynamoelectric machines, with some remarks on the determination of the working powers of electromagnetic motors; by J. Wagner, on the tenacity of solutions of salts; by S. von Wroblewski, on the absorption of gases by fluids under high pressure; by A. Schuller, on distillation in vacuum; by K. R. Koch, on the elasticity of crystals of the regular system; by C. Bohn, on absolute masses; by E. Gerland, on the methods adopted by R. Kohlrausch in his researches in contact electricity. In part iii. papers are contributed by F. Neesen, on the specific heat of water; by E. Ketteler, on the conflicting theories of light (continued in part iv.); by W. G. Hankel, on the thermoelectric properties of helvine, mellite, pyromorphite, mimetesite, phenakite, pennine, strontianite, witherite, cerussite, titanite; by F. Niemöller, on the dependence of the electromotor power of a reversible element on the pressure exercised on its fluidity; by C. Tromme, on experimental researches in magnetism; by K. Vierordt, on sound measurement; by A. Ritter, on the constitution of gaseous bodies; by K. R. Koch, on a method of testing the micrometric screw. Part iv. contains papers by F. Kohlrausch, on the galvanic gauging of the surface coil of a wire bobbin; by C. Tromme, on electrical research; by M. Baumeister, on the experimental investigation of torsion elasticity; by E. Wiedemann, on thermochemical research; by G. Kirchhoff, on the theory of light radiation; by W. Wundt, on sound measurement.

Journal de la Physique, February.—On a spectroscope with great dispersion, by M. Cornu.—On the comparative observation of telluric and metallic lines, as a means of observing the absorbent powers of the atmosphere, by the same.—Researches on the photometric comparison of differently-coloured sources, and in particular on the comparison of different parts of the same spectrum, by MM. Macé de Lepinay and Nicati.—On electric shadows and various connected phenomena (second article), by M. Righi.

Verhandlungen der k.k. Zool.-botan Gesellschaft in Wien, 1882, Bd. xxxix. Heft 2 (March, 1883), contains:—Zoology.—Biological notes on some beetles belonging to the Dascyllidæ and Parnidæ, by Th. Beling.—On Platen's ornithological collections from Amboyna, by W. Blasius.—On a new tortoise, by J. v. Hornig.—On the genus Colias, by A. Keferstein.—On the skin glands in some larvæ, by Dr. Klemensiewicz (Plates 21 and 22).—On new Hymenoptera, by Fr. Kohl (Pl. 23).—On the Myriapods of Austrian-Hungary and Servia, by Dr. R. Latzel.—The butterfly fauna of Surinam, v., by H. B. Möschler (Plates 17 and 18).—On a new mite in the inside of the quill feathers in the hen, by Dr. C. Nörner (Plates 19 and 20).—On a collection of birds from Central Africa, sent by Dr. E. Bey, by A. v. Pelzeln.—On Pselaphidæ and Scydmænidæ, from Java, Borneo, and Central and South America, by E. Reitter.—On *Icaria scudderi*, by Dr. H. Weyenbergh.

THE *Atti* of the Roman *Accademia dei Lincei* for January and February, 1883, contains papers by E. Millosevich, on the ingress of Venus on the solar disk, December 6, 1882; by A. Lugli, on the mean variation of temperature in Italy, as affected by latitude and elevation; by A. Viola, on the relations of some physical properties of gaseous bodies under constant pressure and of constant bulk; by L. Pigorini, on barbaric stations still existing in the Emilian provinces; by Tommasi-Crudeli, on the malaria of the Tre Fontane district, which appears not to have been beneficially affected by the Eucalyptus plantations elsewhere found so efficacious; by S. Tacchini, on meteoric dust and the chemical analysis of the sands of the Sahara; by the same author, on Finlay's comet and on the new asteroid (232) discovered on February 1 by Palisa; by S. Brioschi, on the algebraic relations between the hyperelliptical functions of first order; by S. Ferrari, on the relations between the meteoric elements and some agricultural returns for the year 1880 in Italy.